

Pb isotope composition and Re-Os isotope dating of ore minerals constraint on the genesis of the Tongchang copper-iron deposit in the Qinling orogenic belt, Central China

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The Tongchang deposit, composing of an iron deposit in the lower part and a copper deposit in the upper part, is one of the most representative copper-iron deposits in the Qinling orogenic belt. The ore minerals are mainly magnetite, chalcopyrite, pyrite and minor pyrrhotite, sphalerite, galena, etc. The contents of TiO_2 and Al_2O_3 in magnetite are lower than 1.72 wt% and 1.81 wt%, respectively, showing the characteristics of hydrothermal magnetite. The in-situ Pb isotope compositions ($^{206}\text{Pb}/^{204}\text{Pb} = 18.252\text{-}20.396$ $^{207}\text{Pb}/^{204}\text{Pb} = 15.438\text{-}16.086$ $^{208}\text{Pb}/^{204}\text{Pb} = 38.302\text{-}39.755$) of the chalcopyrite and pyrite were fallen within the range of the upper crust in the tectonic identification diagrams. Moreover, the μ values (9.15-10.3, average of 9.59) of Pb isotope suggested that the ore-forming materials of the Tongchang copper-iron deposit mainly sourced from the U and Th enriched rocks, which is consistent of the high Th-U anomaly of the Guojiagou Formation spilite. The REE distribution patterns of the Tongchang copper ores and the spilite are similar, thus it is indicated that the ore-forming material of the Tongchang copper-iron deposit derived from the spilite of the Guojiagou Formation. Meanwhile, the Re-Os isotopic isochron age of the five chalcopyrite samples is 484 ± 34 Ma (MSWD=8.7), indicating that the Tongchang copper-iron deposit was formed in the early Paleozoic Caledonian period.

The Tongchang copper-iron deposit should be classified as the iron oxide copper-gold deposit (IOCG) type and its formation can be divided into two stages: (1) in Neoproterozoic Jinning period, Rodinia supercontinent breakup event leads to submarine volcanic eruption and the formation of initial source bed which was enriched in Fe and Cu; (2) in the Caledonian period of Early Paleozoic, the continuous cracking and rifting of the continental margin formed the Mian-Lue trough and led to intense magmatic activity. The magmatic-hydrothermal fluid enriched in volatile (include F , Cl , CH_4 , etc) and sulfur, mixed with seawater sulfur, and extracted Fe, Cu from the spilite of the Guojiagou Formation. The early and late ore-forming hydrothermal fluid in the Caledonian period formed the iron ore deposit in the lower part and the copper deposit in the upper part, respectively.